C3

Technical Report No. 88-04

Red-backed Vole and Snowshoe Hare Populations in Relation to Four Boreal Forest Community Types on Long Point Peninsula, Manitoba, 1971-1987.

By W.H. Koonz

Manitoba
Natural Resources
Wildlife
Biological Services

Abstract

Annual surveys of red-backed voles (Clethrionomys gapperi) and snowshoe hares (Lepus americanus) were conducted in fall on Long Point Peninsula, Manitoba, from 1971-1981, and 1983-1987. Population indices were compared among four boreal forest communities (mature black spruce, immature black spruce, mature jack pine and immature jack pine)*. Red-backed vole populations were near peak in 1971, 1975, 1980 and 1987. Hare populations declined dramatically in 1971 and remained low until increasing sharply in 1977. Densities remained high through 1980, declined in 1981 and further through 1985, and remained low in 1986 and 1987. During population lows, hares and voles concentrated in immature spruce thickets. Their fluctuations were most pronounced in early successional stages of forest growth (jack pine). Vegetation analysis in the four community types during 1971 and 1980 indicated that shrub densities increased along a soil moisture gradient from dry to wet, although, species diversity decreased. Dry sites had a primarily jack pine overstory being invaded by black spruce; wetter sites contained a black spruce overstory being invaded by more spruce. Total basal area and tree stem numbers decreased in the 200-year old mature spruce and 130-year old jack pine forest during the 9-year sampling interval, indicating over-maturity. Shrub densities and ground cover in all four forest communities were similar for the two sampling periods.

*A list of common and scientific names of plants found on Long Point is given in Appendix I.

ACKNOWLEDGEMENTS

This study was initiated by Dr. C. G. Van Zyll de Jong (now Curator of Mammalogy at the National Museum of Natural Sciences, Ottawa). Dr. Donald A. Rusch (now with the University of Wisconsin, Madison) supported the project and assisted in the original vegetation analysis. Dr. Merlin W. Shoesmith and Dr. Robert W. Nero contributed data, lent encouragement and edited the manuscript. Other past and present Branch personnel who contributed to the study include: Douglas R. Storey, Kathy M. Storey, R. Douglas Pastuck, Donald Glays, Calvin Cuthbert, Louis L'Arrivee and, importantly, Walter Cook, a local Grand Rapids trapper. Dr. Robert E. Wrigley, Manitoba Museum of Man and Nature, provided the weight estimates for hares and small mammals.

TABLE OF CONTENTS

	Page
ABSTRACT	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF FIGURES	v
LIST OF TABLES	vi
INTRODUCTION	1
DESCRIPTION OF THE STUDY AREA	2
METHODS AND MATERIALS	4
Small mammals and snowshoe hares	4
Vegetation	7
RESULTS	7
Snowshoe hares	7
Small mammals	10
Vegetation	10
Trees	10
Saplings	14
Shrubs	14
Ground cover	17
DISCUSSION	17
Snowshoe hares	17
Small mammals	20
Vegetation	20
Fire suppression and dwarf mistletoe	21
Mature jack pine forest	21
Mature black spruce forest	21
Immature jack pine forest	21
Immature black spruce forest	22
Wildlife cycles in relation to observations on Long Point	22
CONCLUSIONS	26
LITERATURE CITED	27
APPENDIX I. Names of plants found on Long Point	29

LIST OF FIGURES

		Page
Fig. 1	Long Point and surrounding areas.....	3
Fig. 2	Long Point road and census plot locations.....	5
Fig. 3	Long Point plot dimensions and grid pattern.....	6
Fig. 4	Mean hare productivity by forest type, 1971-87.....	9
Fig. 5	Mean fall biomass of hares in four forest cover types: 1971-87.....	9
Fig. 6	Mean red-backed vole productivity by forest type: 1971-87.....	12
Fig. 7	Mean standing biomass of red-backed voles in four forest cover types: 1971-87.....	12

LIST OF TABLES

	Page
Table 1. Snowshoe hare live-trapping results, 1971-87.....	8
Table 2. Small mammal live-trapping results, 1971-87.....	11
Table 3. Stem density, mean distance, basal area per hectare and mean basal area per tree in mature black spruce and jack pine forest communities: 1971 and 1980.....	13
Table 4. Relative importance value of trees and samplings in four forest communities: 1971 and 1980.....	13
Table 5. Ages and heights of six representative trees from each of four boreal forest communities: 1971.....	15
Table 6. Stem density, mean disturbance, basal area per hectare and mean basal area per sapling in four boreal forest communities: 1971 and 1980.....	15
Table 7. Relative importance value for shrubs in four boreal forest communities: 1971 and 1980.....	16
Table 8. Percent frequency of ground cover in four boreal forest communities: 1971 and 1980.....	18
Table 9. Moss and lichen ground cover showing incidence, relative importance and average cover for 25 samples in each of four boreal forest communities: 1971 and 1980.....	19

INTRODUCTION

The abundance of many furbearers, and perhaps other species, is directly linked to the density of the snowshoe hare (Lepus americanus) making it the keystone species of the northern boreal forest community (Loewen and Mowat 1987). A 10-year cycle in snowshoe hare numbers has been well documented and many authors have struggled with the cycle's mechanics. Recently, Keith et al. (1984) looked at food availability, predation and body weights of snowshoe hares during a population decline in Alberta. Their results indicate that food and predation are major factors in the hare cycle.

The objective of this study was to determine the annual and long term variations in red-backed vole (Clethrionomys gapperi) and snowshoe hare densities in four boreal forest communities on Long Point Peninsula, Manitoba. The ground cover component and species composition of shrubs, saplings and trees were to be assessed in order to indicate forest productivity, age of stands and relative abundance of food available to small mammals and hares in relation to cover type. The resulting information was considered useful in wild furbearer management, and in predicting annual population trends in terrestrial furbearer species. These data could be useful to foresters in determining seeding rates per area and in predicting seedling survival. Long Point was chosen because of its accessibility, relatively small amount of human disturbance and boreal habitat diversity over short lateral distances.

DESCRIPTION OF THE STUDY AREA

Long Point Peninsula extends some 50 km from the west side of Lake Winnipeg south of Grand Rapids, Manitoba (Fig. 1). It is composed chiefly of a limestone bedrock ridge with slight overlying glacial till and shallow soil. The south side of the ridge rises rapidly in a series of steps to 50 m above the lakeshore; the north side has a more gradual rise with several streams and long narrow fens dominating the land surface. Long Point is in the northern boreal forest zone where black spruce (Picea mariana) is the predominant tree species; jack pine (Pinus banksiana) grows on the ridge top (where a fire history is evident); white cedar (Thuja occidentalis) is common along many of the fens where it competes with tamarack (Latrix laricina). The area's mean annual minimum temperature is near -45°C with an annual maximum near 30°C. Precipitation is notably higher on the ridge than in surrounding areas, with total amounts averaging near 45 cm annually. Of this, one-third falls as snow (Weir 1960). Provincial records indicate that no major fires occurred on Long Point between 1928 and 1980. Several thousand hectares burned in 1980, but the study plots were not affected.

Owing to extensive bog and fen areas, dense black spruce and steep terrain, there is little trapping on Long Point except in areas close to the road. Wind, rocks, rough water and ice ridges make access via the lake shore difficult and dangerous.

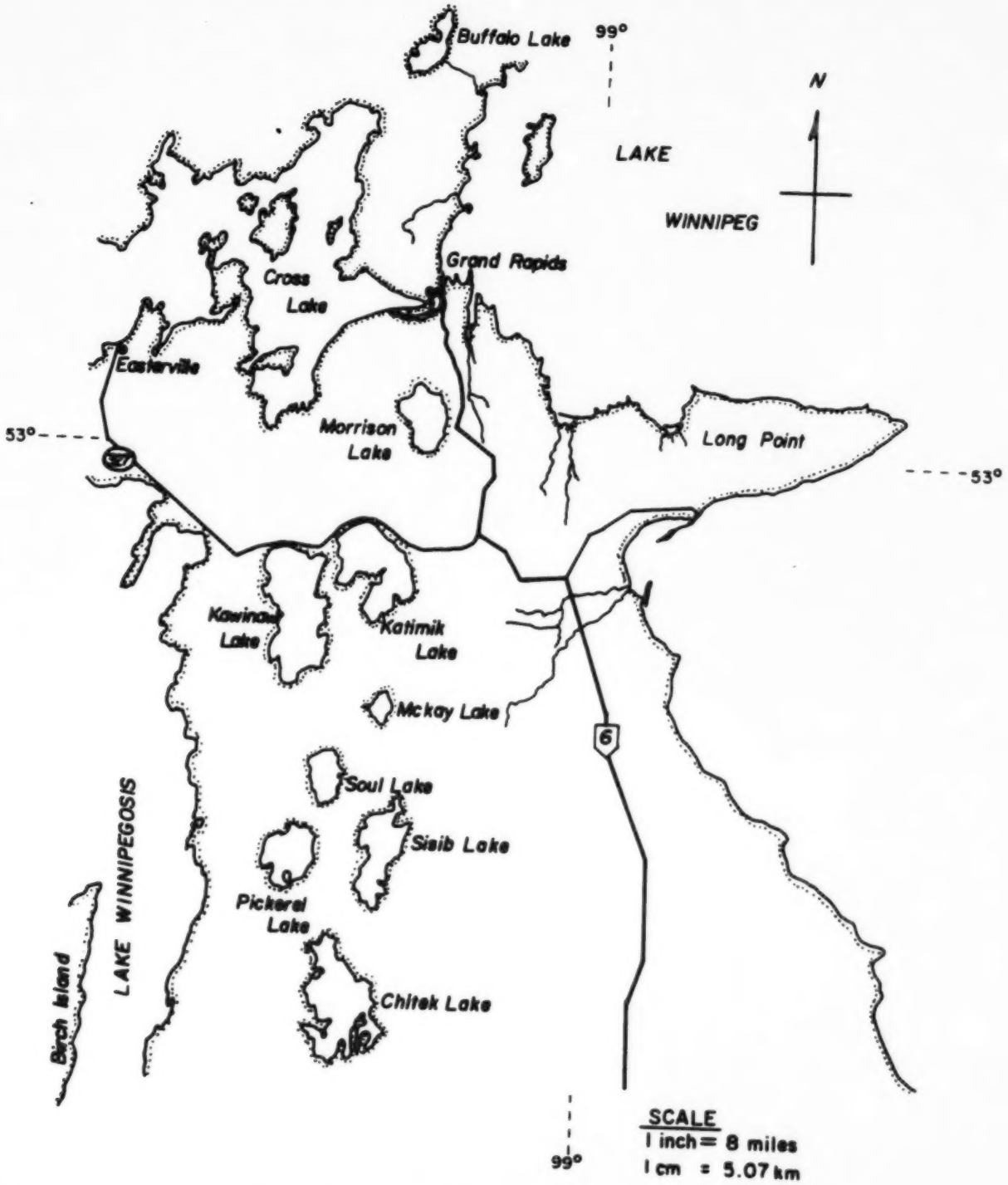

Figure 1. Long Point and surrounding areas.

METHODS AND MATERIALS

Small Mammals and Snowshoe Hares

Small mammal and hare live-trapping studies were conducted in each of four forest community types (mature black spruce, immature black spruce, mature jack pine and immature jack pine) (Fig. 2). Plots 200 m by 200 m (4 ha) were established in each community type. A 50 m grid was applied to each plot with the southeast quarter of each having a 25 m grid (Fig. 3). All 50 m and 25 m grid corners were staked with 46 cm lathes. A limited amount of line clearing and colour marking was required to facilitate mobility throughout the grids.

All hare and small mammal trapping was done in September, 1971-87 (no trapping was done in 1982). Hares were trapped in single-door Tomahawk live-traps (22.9 cm by 22.9 cm by 61 cm long). Traps were placed at 50 m intervals along the grid system of each plot (Fig. 3). Traps were baited with pieces of fresh apple and covered with canvas, spruce boughs or moss to simulate cover. They were set each evening, checked and closed each morning for four nights in each plot. Trapped hares were individually marked with permanent ink and released. Live-trapping of small mammals was conducted in the southeast quarter of each plot (Fig. 3) and was concurrent with hare trapping. Traps remained open and were checked for 4 nights and 3 days in each plot. Sherman live-traps were used in 1971 and 1972. For the remainder of the study, Longworth live-traps were used exclusively. Bait consisted of liberal amounts of a mixture of peanut butter, hulled cracked buckwheat, sliced raisins and bacon grease. Traps were set within 1 m of each 25 m grid marker. Each trapped animal was placed in a plastic bag, identified, sexed, aged, marked with permanent ink on its ventral surface and released. Hare and small mammal population sizes were estimated using the Lincoln Index (Giles 1969).

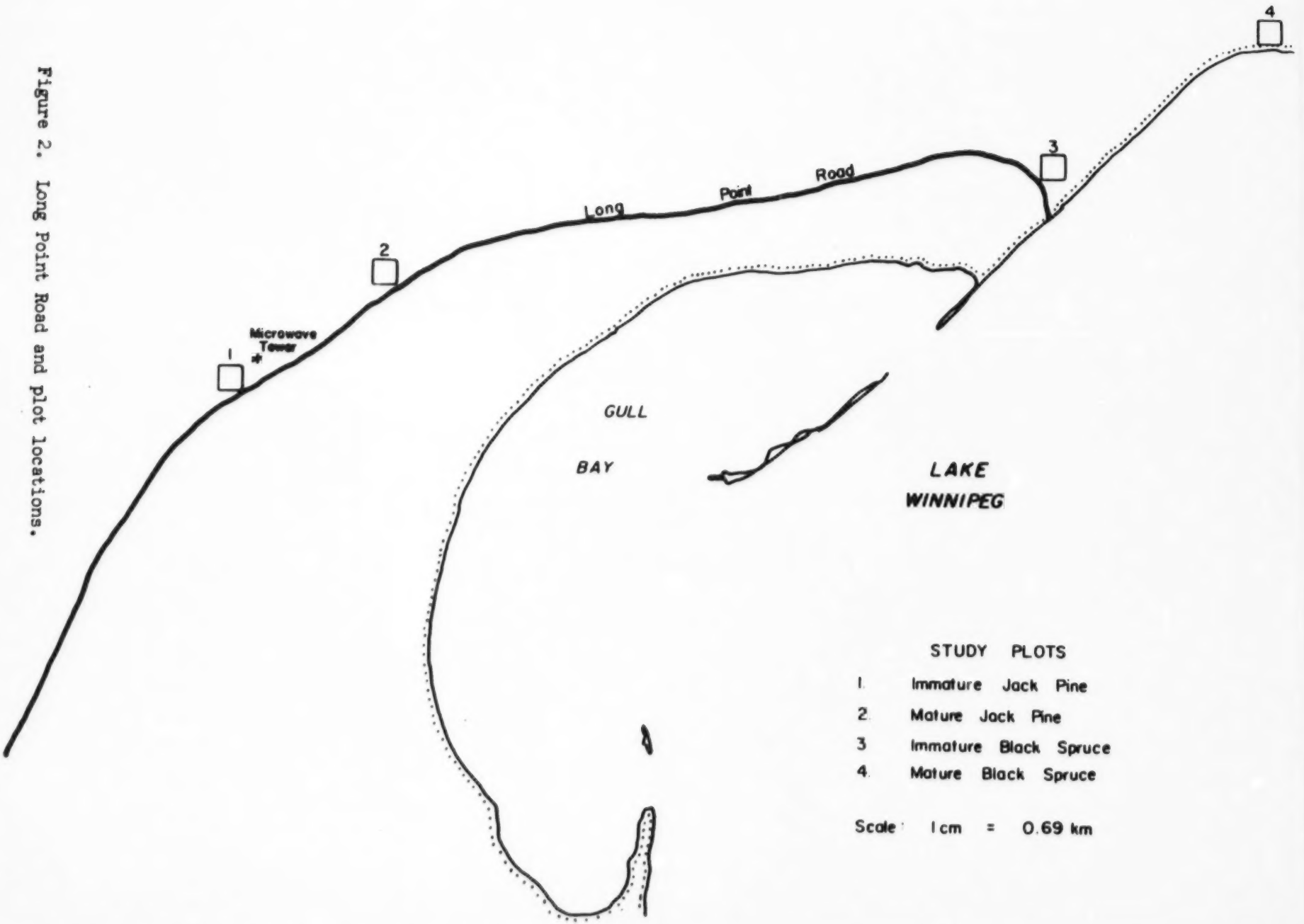

Figure 2. Long Point Road and plot locations.

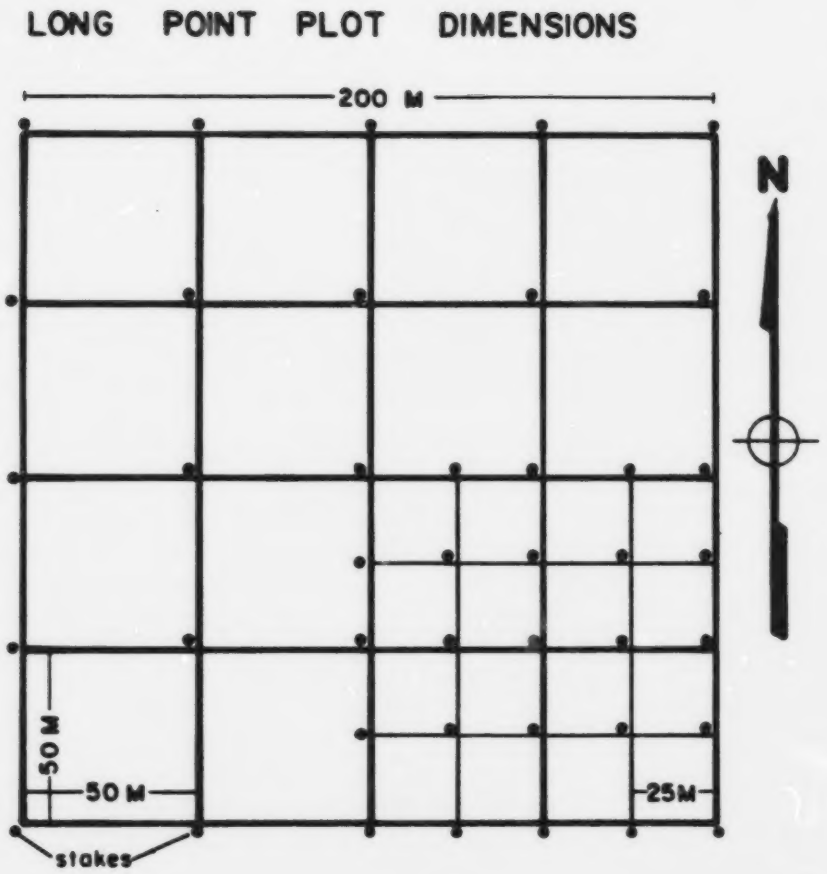

Figure 3. Long Point plot dimensions and grid pattern.

Vegetation

The point-quarter method (Smith 1966) was used to sample tree, sapling and shrub basal area, frequency and average mean distance in the four Long Point forest communities in 1971 and 1980 (Fig. 2). Twenty-five random points were sampled in each forest community. Tree heights were estimated at each point with the aid of a Hega altimeter. An increment borer was used to sample six trees in each plot for age of stand determination.

A quadrat frame 25 cm by 25 cm was randomly thrown 25 times in each forest community in 1971 and in 1980 to sample ground vegetation. The number of stems for all plants under 30 cm tall and the percent cover of each species in each quadrat was recorded (Phillips 1959).

RESULTS

Snowshoe Hares

A trial catch in June 1971 revealed considerable numbers of hares on Long Point. By September 1971, however, densities had declined considerably. They continued low until 1977 when a dramatic increase was identified (Table 1). The population continued to increase through 1978 before decreasing slightly in 1979, then rising to near peak densities in 1980. A drastic reduction had occurred in all but the immature jack pine plot by fall 1981. Observations during fall 1982 indicated low population densities for all habitats with the exception of a few pockets of immature black spruce uplands (not in the study plots). Populations continued to decline through 1985. A slight increase was detected in 1986, but 1987 catches were very low.

Over the 17 years of trapping data collection, immature jack pine and black spruce forest plots contributed 65% of the annual hare biomass (Fig. 4). Considering each hare to weigh 1,500 grams, standing mean hare biomass estimates ranged from less than 300 g/ha to over 10,000 g/ha (Fig. 5). In only 5 of 16 years was the standing biomass above the mean (it can be assumed that the 1982 biomass was also below the annual mean).

Table 1. Snowshoe hare live-trapping results in four hectare plots on Long Point, 1971-1987*

Hares per four hectares of habitat

Year	Mature jack pine		Immature jack pine		Mature black spruce		Immature black spruce		Totals	
	Captures	Recaptures	Captures	Recaptures	Captures	Recaptures	Captures	Recaptures	Captures	Recaptures
71	5	7	13	10	0	0	5	7	23	24
72	0	0	1	0	0	0	2	0	3	0
73	0	0	1	0	0	0	2	0	3	0
74	0	0	3	0	1	0	5	1	9	1
75	0	0	7	1	1	0	0	0	8	1
76	3	0	7	5	1	3	5	4	16	12
77	7	3	17	9	3	4	6	1	33	17
78	13	4	22	18	17	4	18	3	70	29
79	2	0	10	3	11	4	21	11	44	18
80	22	4	6	1	8	5	24	13	60	23
81	4	1	9	4	5	2	3	2	21	9
83	1	0	1	0	0	0	1	0	3	0
84	0	0	0	0	0	0	4	2	4	2
85	1	0	0	0	0	0	3	4	4	4
86	0	0	0	0	4	2	9	5	13	7
87	0	0	1	0	3	3	2	0	6	3
Totals	58	19	98	51	54	27	110	53	320	150

*No trapping was done in 1982.

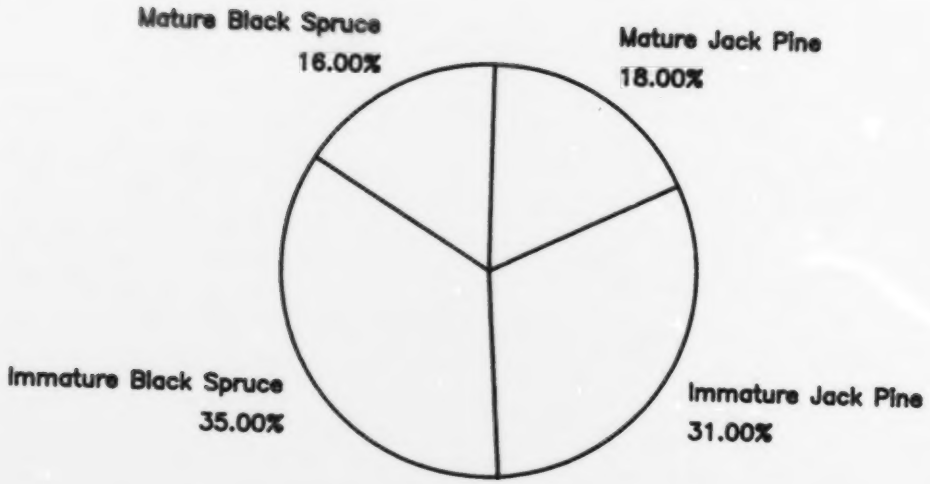

FIG. 4. MEAN HARE PRODUCTIVITY BY FOREST TYPE 1971–1987.

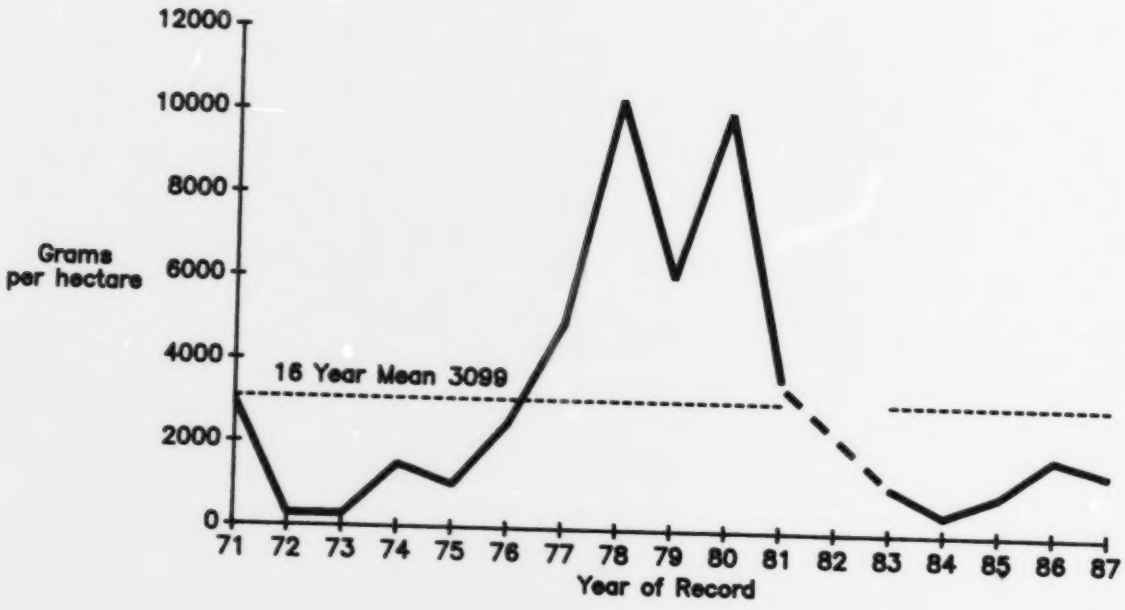

FIG. 5. MEAN FALL BIOMASS OF HARES IN FOUR FOREST COVER TYPES: 1971–1987.

Small Mammals

Small mammal species captured on Long Point were: red-backed vole, meadow vole (Microtus pennsylvanicus), masked shrew (Sorex cinereus), pygmy shrew (Microsorex hoyi), arctic shrew (Sorex arcticus), least weasel (Mustela rixosa), shorttail weasel (Mustela erminea), least chipmunk (Eutamias minimus) and northern bog lemming (Synaptomys borealis). Only the masked shrew and the red-backed vole were captured with consistency, and only the red-backed vole lent itself to the capture-recapture technique. The 16 years of data (Table 2) represent only red-backed vole populations. Small mammal populations in all habitats were at peak densities in 1971 (the only year meadow voles were recorded), decreased to a low in 1973, and peaked again in 1975. During the years 1976 through 1978, they were generally in decline, leveling off in 1979 prior to an increase in 1980. Populations were on the decline in 1981. Results from 1983-87 indicate low to moderate densities with a small peak in 1987.

Over the 17-year trapping period, black spruce forest plots contributed over 65% of the small mammal catch (Fig. 6). These habitats afforded the best cover conditions for the available food. Mean annual population estimates for the four Long Point forest community types ranged from fewer than 6/ha to over 100/ha. Considering an average weight for an adult vole to be 22 g, the estimated mean annual standing biomass of voles/ha ranged from 132 g to nearly 2,400 g (Fig. 7). The annual standing biomass mean was only above the 16-year average in 5 study years.

Vegetation (A list of common and scientific names of plants found on Long Point is given in Appendix 1).

Trees

The number of trees per area decreased in mature jack pine and black spruce forest plots between 1971 and 1980 (Table 3). Average basal areas increased in both plots and total basal area per hectare decreased (Table 3). In the mature jack pine, jack pine had a relative importance value of 75% in 1971, dropping 51% in 1980 (Table 4). The basal area of black spruce in the jack pine plot more than doubled from 30.7 m^2/ha in 1971 to 63.5 m_2/ha in 1980. These data show that dying jack pine were opening

Table 2. Long Point red-backed vole live-trapping results, 1971-87*

	Number of red-backed voles per hectare			
Year	Mature jack pine	Immature jack pine	Mature black spruce	Immature black spruce
1971	95	70	120	150
1972	8	3	26	30
1973	1	5	8	10
1974	15	16	41	40
1975	28	45	50	100
1976	10	20	25	35
1977	5	6	35	18
1978	4	1	17	13
1979	5	10	15	17
1980	42	45	53	54
1981	15	10	45	55
1983	31	12	25	30
1984	20	10	45	45
1985	10	11	33	30
1986	15	15	45	20
1987	50	30	40	45
TOTAL	364	309	623	647
MEAN	23	19	39	43

*No trapping was done in 1982.

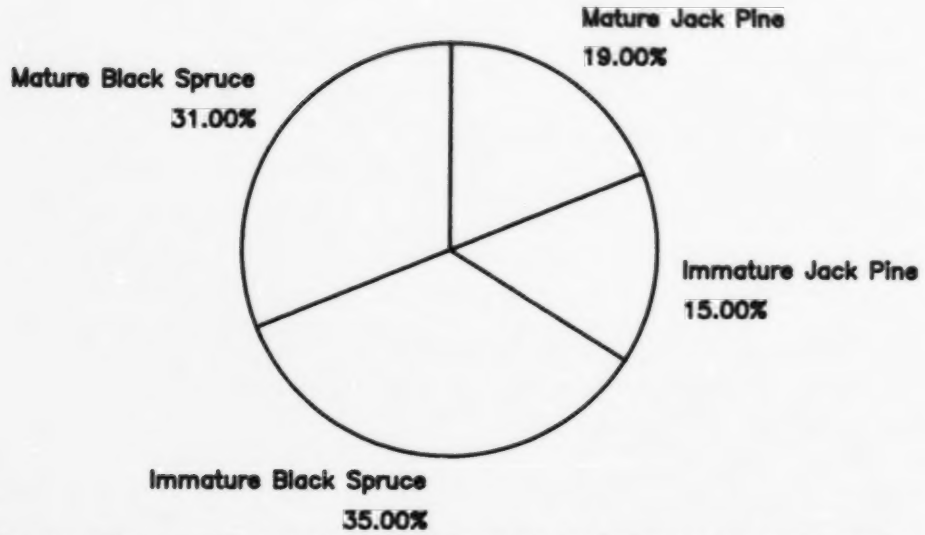

FIG. 6. MEAN RED-BACKED VOLE PRODUCTIVITY BY FOREST TYPE 1971-1987.

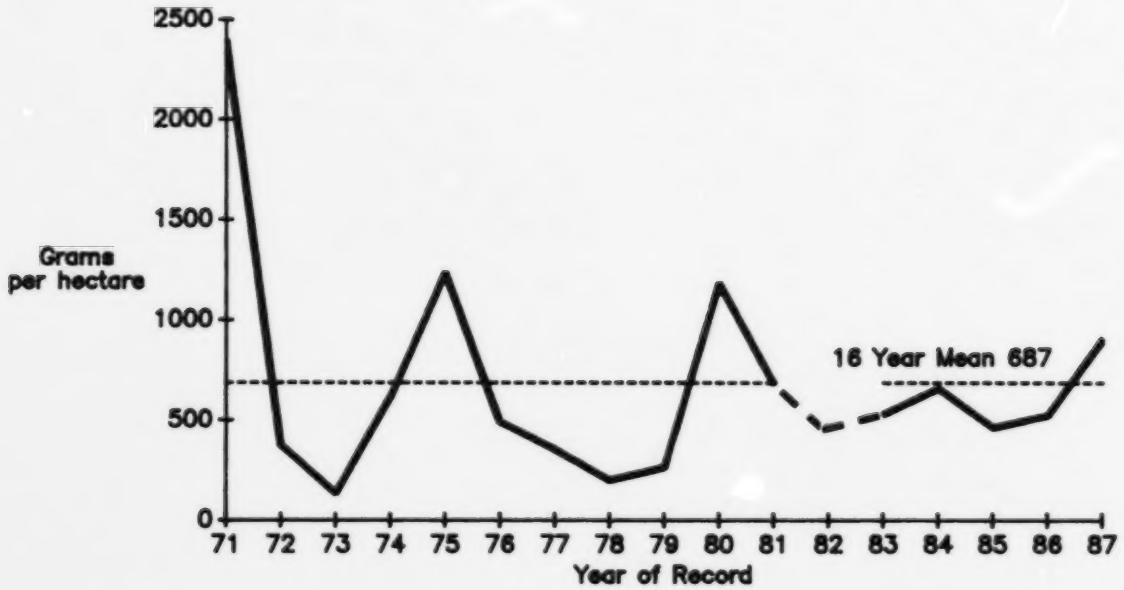

FIG. 7. MEAN STANDING BIOMASS OF RED-BACKED VOLES IN FOUR FOREST COVER TYPES: 1971-1987.

Table 3. Stem density, mean distance, basal area per hectare and mean basal area per tree in mature black spruce and jack pine forest communities: 1971 and 1980.

Habitat type	Stems/hectare		Mean distance (cm)		Basal area (m^2/hectare)		Mean basal area (m^2)	
	1971	1980	1971	1980	1971	1980	1971	1980
Mature jack pine	789	564	356	421	167	144	0.21	0.25
Mature black spruce	1,559	1,222	253	286	221	196	0.14	0.16

Table 4. Relative importance value of trees and saplings in four boreal forest communities: 1971 and 1980.

Species	Immature jack pine		Mature jack pine		Immature black spruce		Mature black spruce	
	1971	1980	1971	1980	1971	1980	1971	1980
Trees								
Jack pine			75	51				
Black spruce			25	49			100	100
Saplings								
Jack pine	66	48	6					
Black spruce	34	50	88	94	98	91	98	100
White birch		2	5	6				
Red cedar			1					
Alder sp.					2	8	2	
Willow sp.						1		

the canopy for black spruce maturation. The mature spruce trees were 200 years old in 1971 and the decadent jack pines of the mature jack pine plot were 130 years old (Table 5).

The immature black spruce forest showed considerable variation in tree height likely relating to moisture variations. The immature jack pine stand presumably grew up after the last major Long Point fire in 1928. Neither immature forest plot can be considered immature at present.

Saplings

Over the 9-year sampling interval, the density of saplings increased in the immature black spruce and mature jack pine forest plots, but decreased in the mature black spruce and immature jack pine plots (Table 6). The number of sapling stems did not approach tree stem numbers in either the mature black spruce or mature jack pine, suggesting that neither community is self-sustaining at present biomass levels. The decrease in jack pine stems in the immature jack pine plot resulted from natural thinning and a severe infestation of dwarf mistletoe. A number of saplings in the immature black spruce plot grew to tree size during the 9-year sampling interval. All four forest communities showed an increase in sapling zone basal area per ha over the 9-year sampling interval despite a drastic reduction in stems per area in the immature jack pine and a lesser reduction in the mature black spruce.

Shrubs

The sampling data (1971 and 1980) indicate considerable variation in shrub density and composition in the four forest communities. The two jack pine plots each contained over 20 shrub species, the mature black spruce contained only three. Despite the low species number, stem density in the black spruce was nearly triple that recorded in the jack pine plots (Table 7). Data indicate that considerable changes in shrub relative importance values occurred between the two periods (Table 7). Some changes relate to the times of year that the sampling was done (July 1971; late August 1980); some species are more dominant at one time of the year than others. Moisture conditions, as well as hare and small mammal population

Table 5. Ages and heights of six representative trees from each of four boreal forest communities: 1971.

Habitat type	Age in years	Average age	Height range in metres	Average height in metres
Immature jack pine	40-53	45	5.3-9.1	6.7
Mature jack pine	115-125	121	11.3-16.8	14.0
Immature black spruce	37-44	40	3.7-11.3	7.6
Mature black spruce	150-205	185	10.6-14.3	12.2

Table 6. Stem density, mean distance, basal area per hectare and mean basal area per sapling in four boreal forest communities: 1971 and 1980.

Habitat type	Tree species	Stems/hectare		Mean distance (cm)		Basal area (m^2/hectare)		Mean basal area (m^2)	
		1971	1980	1971	1980	1971	1980	1971	1980
Immature jack pine	jack pine	3,569	1,720			103	123	0.03	0.07
	black spruce	1,838	1,792			42	44	0.02	0.02
	white birch		72						0.05
	total	5,407	3,584	136	167	145	166		
Mature jack pine	jack pine	7				0.17		0.01	
	black spruce	105	230			3.4	4.76	0.02	0.02
	white spruce	6	15			0.06	0.25	0.01	0.01
	white cedar	1				0.02		0.07	
	total	119	245	911	639	3.25	5.01		
Immature black spruce	black spruce	3,514	4,213			70.3	87.0	0.02	0.02
	alder sp.	72	370			0.7	2.3	0.01	0.01
	willow sp.		46			0.5		0.01	
	total	3,586	4,629	167	147	71.5	89.3		
Mature black spruce	black spruce	1,161	1,947			19.0	21.4	0.02	0.02
	alder sp.	24				0.2		0.01	
	total	1,185	1,047	273	309	19.2	21.4		

Table 7. Relative importance value for shrubs in four boreal forest communities: 1971 and 1980.

Species	Immature jack pine		Mature jack pine		Immature black spruce		Mature black spruce	
	1971	1980	1971	1980	1971	1980	1971	1980
Black spruce	36	18	16	7	20	15	12	16
Rose sp.	27	43	26	35	2			
Alder sp.	1				3	5		
Labrador tea			2	3	63	58	82	82
Bog rosemary					9	21	6	2
Skunkberry					2			
Willow sp.	1				2			
Leatherleaf	21	10	22	10				
Juniper	3	4	14	12				
Potentilla sp.	6		8	12				
Snowberry	3	11	2	4				
Saskatoon	1	6	4	4				
Chokecherry	1	1						
Honeysuckle			2	1				
Jack pine			3	2				
Blueberry		1		4				
Red osier dogwood						1		
Ground cedar				2				
White birch		2		2				
Highbush-cranberry		4						
Stems/hectare	23,984	20,000	14,238	14,493	172,176	166,667	58,820	61,500

levels also affect shrub species dominance and stem densities. Total numbers of shrub stems per ha were reasonably consistent for the two sampling periods.

Ground Cover

Ground cover data in the four vegetation plots revealed several significant vegetative groups: mosses and lichens, grasses and sedges, forbs and shrubs (Table 8). Changes over the 9-year period in general were slight with exceptions primarily due to differences in interpretation (feather moss), moisture conditions (sedges), and time of year (several grass, sedge, forb and fungi species).

All forest plots contained large areas of mosses and lichens in their ground cover zones with little change detected over the 9-year sampling interval (Table 9).

DISCUSSION

Snowshoe Hares

Snowshoe hare populations exhibited large density fluctuations between 1971 and 1987. These changes took several years to attain maximum peaks and draws. Fluctuations in hare populations influence local predators, particularly the red fox (Vulpes fulva), lynx (Lynx canadensis), great horned owl (Bubo virginianus), northern goshawk (Accipiter gentilis), coyote (Canis latrans) and fisher (Martes pennanti). Over the 1977-81 period, hare densities remained high. During those years, predator observations increased dramatically and upland gamebird populations, including spruce grouse (Canachites canadensis), sharp-tailed grouse (Pedioecetes phasianellus), and ruffed grouse (Bonasa umbellus), declined significantly. This upland gamebird decline continued into the fall of 1983, before beginning a slow recovery that continued through 1987.

The fact that snowshoe hare densities remained high on Long Point for more than 4 years (1977-1981) when populations north of Grand Rapids crashed after only 2 years (1977-79), warrants discussion. Several factors appear to have interracted, namely: 1) The winter of 1978-79 was severe, with an early snowfall, deep accumulation and late spring.

Table 8. Percent frequency of ground cover in four boreal forest communities: 1971 - 1980.

Species	Immature jack pine		Mature jack pine		Immature black spruce		Mature black spruce	
	1971	1980	1971	1980	1971	1980	1971	1980
Mosses and lichens								
Flat feather moss	60	64	92	88	42	68	92	78
High feather moss	32	12	4		12		20	16
Sphagnum sp.					60	44	16	28
Gray cup lichen	56	52	16	20	8	16	4	4
Reindeer lichen	72	63	52	64				
Mushrooms		23		20		24		24
Red cup lichen		4						
Grasses and sedges								
Grass	72	64	28	88	12	8		
Sedge	40	32	56	20	12			
Forbes								
Twinflower	88	80	80	88	4			
Horsetail	14	8			28	44	28	40
Bunchberry	16	20	48	32	16			
Lily sp.	12	8	36	28				
Bedstraw	20	12	24	8				
Aster sp.			36					
Viola sp.	28	32	4	32				
Bishop's cap			4		4			
Indian pipe			4					
Vetch sp.	4							
Soapberry			4					
Palmated coltsfoot			4					
Strawberry	56	64	52	64	4			
Harebell	4	4		4				
Cow wheat			4					
Dewberry		8	4	25				
Cloudberry					8	20		4
Sundew								4
Star flower					4			
Shrubs								
Bearberry	80	76	96	96				
Labrador tea					84	88	68	92
Cranberry	12	32	24	12	88	84	56	84
Rose sp.	4	28	12	16	4			
Creeping snowberry	4		28	16	48	48		20
Blueberry	20	12	12	16				
Saskatoon	12	4	4					
Bog laurel							4	
Crowberry							4	4
Potentilla sp.				4				
Buffalo-berry	4							
Honeysuckle	4							
Red osier dogwood						4		
Bog rosemary					8	40	16	20

Table 9. Moss and lichen ground cover showing incidence, relative importance and average cover for 25 samples in four boreal forest communities: 1971 and 1980.

Cover type	Immature jack pine				Mature jack pine				Immature black spruce				Mature black spruce			
	% Incidence		Relative Importance		% Incidence		Relative Importance		% Incidence		Relative Importance		% Incidence		Relative Importance	
	1971	1980	1971	1980	1971	1980	1971	1980	1971	1980	1971	1980	1971	1980	1971	1980
Feather moss	75	64	19	22	92	88	50	55	54	68	31	47	100	82	66	70
Sphagnum spp.									60	44	41	32	16	28	10	20
Reindeer lichen	72	64	14	20	52	64	11	13	44	16	20	10				
Cup lichen	56	52	Trace		16	20	2	1	8		Trace		4	4	Trace	
Mushrooms		28		5		20	Trace			24	Trace			24	Trace	
Range in %	15-100				20-100				25-100				31-100			
Average cover in %	40				77				87				86			

The hare population crashed that winter north of Grand Rapids where food supplies were probably exhausted before spring. According to local trappers, considerable numbers of Long Point hares died that spring, reducing the population before predators had increased substantially and before food and cover had been exhausted. 2) The winters of 1979-80 and 1980-81 were relatively snow-free and milder than normal providing better winter survival conditions for hares. 3) Predator populations, e.g., raptors, red fox, lynx, coyote and fisher, increased to high densities on Long Point between 1977 and 1982. This increase was partly due to ample food supplies (snowshoe hares) allowing for survival of juveniles, but predator migration into the area from the north, where hares crashed in 1979, is also suspected. Winter stress, causing a reduction in the snowshoe hare population prior to food depletion, followed by several unstressful winters and an immigration of predators into the area, allowed local hare populations to survive longer than expected at near peak densities.

Small Mammals

Red-backed vole densities were greatest in 1971, 1975, 1980 and 1987. Black spruce was consistently the most productive habitat. Jack pine habitats with some food availability but lacking cover contained few small mammals unless the overall population was near peak. In jack pine habitats, during population lows, it was not uncommon to catch the same individual in traps 100 m apart on successive nights. This occurrence suggests that voles have large home ranges, at least when populations are low.

As small mammal densities increase, observations of raptors such as the northern harrier (Circus cyaneus), northern hawk-owl (Surnia ulula) American kestrel (Falco sparverius) and red-tailed hawk (Buteo jamaicensis) also increase.

Vegetation

Density and trends in small mammal and snowshoe hare populations may significantly affect forest regeneration. If small mammal populations are at a peak when forests are cut or when seeds are distributed over a cutover area, seed and seedling survival rates will be lower than if small mammal populations are low. The effect of high small mammal and hare

densities on the density and composition of shrub and ground cover species requires further study.

Fire Suppression and Dwarf Mistletoe

Jack pine is a species well adapted to fire in the boreal forest environment. Without the periodic occurrence of fire the species would disappear from the boreal forest (Cayford and Mckae 1983). Dwarf mistletoe is a parasite that attacks jack pine trees, eventually killing its hosts. It is not new to North America, in fact it is as much a part of our heritage as the coniferous forests themselves (Wicker 1978). Dwarf mistletoe is not considered as a major destructive force to coniferous forests prior to the European settlement of North America (Wicker 1978, Parmeter, 1978). Fire suppression and the development of the firest industry have assisted in the spread of dwarf mistletoe attacks (Zimmerman and Laven 1984).

Mature Jack Pine Forest

A decline in tree numbers, total basal area and especially jack pine incidence over the 9-year sampling interval, illustrate that the Long Point turnover rate for jack pine forest is less than 130 years. Dying jack pines were being replaced by grassy openings, shrubs and maturing black spruce trees. Although this habitat contained the greatest diversity it had the lowest density of shrubs and ground cover. Such diversity and a decline in the dominant species (jack pine) indicates a transitional forest.

Mature Black Spruce Forest

Declines in tree stem numbers and total basal area over the 9-year sampling interval illustrate that the Long Point turnover rate for black spruce forest is less than 200 years. The near monoculture of black spruce in both the understory and tree zone and the low diversity of shrub and ground cover species indicates a stable forest community which can sustain itself over time under consistent favourable climatic conditions.

Immature Jack Pine Forest

A reduction by one-half the number of live jack pine sapling stems over the 9-year sampling interval demonstrates the severity of the dwarf

mistletoe attack and competition for available sunlight and nutrients. Black spruce stem numbers remained constant in the samples. Given its growth and density, black spruce will continue to increase its dominance at the expense of jack pine and various shrub and ground cover species.

Immature Black Spruce Forest

The immature black spruce forest matured between 1971 and 1980. The number of tree stems in the 1971 shrub zone sample was somewhat reduced by 1980, as was the density and diversity of shrubs, indicating canopy development. This cover type will, barring natural disaster, show a reduction in sapling, shrub, and ground cover diversity while increasing in black spruce dominance.

Wildlife Cycles in Relation to Observations on Long Point

For many years population cycles have frustrated scientists, authors and local residents. Many theories have developed regarding the phenomenon. Keith (1963) attempted to combine and describe four categories of theories (overpopulation, enemy-prey oscillations, meterological phenomenon and random fluctuations). Lack (1954) described 12 theories for ruffed grouse cycles alone. Many physical factors interact to influence the time and magnitude of cyclic fluctuations. These include parasites, climate, genetics, crowding, energy expenditure and nutrients. The 17 years of Long Point data indicate that food and cover, habitat mix and predators have the greatest influences on snowshoe hares in the four habitats monitored there. These observations agree closely with those of Keith et al. (1984) from Alberta studies and Norberg (1987) for cyclic prey species in northern Europe.

In 1970-71 and 1980-81, after several years of density increase accompanied by increases in predator populations, Long Point hares declined drastically. Remaining hares concentrated in dense cover areas (immature spruce thickets). Wolff (1982) in Alaska, and Keith (1984) in Alberta, also recorded surviving hare concentrations in dense cover after population crashes. ("Hare pockets" are often described by Manitoba trappers as places where hares congregate after the main population declines. Trappers seek

them out because fisher and lynx can be taken there for one or more years after hares have become generally scarce).

High predator densities and low hare densities depress not only Long Point's hare populations, but also negatively impact on small mammal, muskrat (Ondatra zibethica), red squirrel (Tamiasciurus hudsonicus) and grouse populations. This impact continues for some time, even though survival of young predators is minimal due to food shortages.

After a Long Point hare crash, surviving predators are primarily experienced hunters that continue to feed mainly on hares, concentrating in (hare pocket) thickets where heavy browsing by hares has reduced the protective cover considerably. Predators further depress hare populations because food and cover remain scarce. It may take several years before most of the predators die off, move on or shift their food habits; by that time, vegetation has recovered to supply food and cover for the few remaining hares. As the hare density increases, individuals begin moving out of dense cover into more open areas (jack pine, willow, alder, aspen) where a wider variety of food is available but where cover is scarce. When hares increase in these open areas they are again more vulnerable to predation, and young of the year predators can survive due to an easily obtained food source. Large hare densities affect local vegetation, reducing cover and increasing the distance traveled to obtain food. They produce the typical "hare line" often evident throughout their Manitoba range. It is a time of maximum predator reproductive success; hares are abundant and easy to catch. This is also the stage when hares are most affected by parasites and crowding. Once hares have largely exhausted available supplies of food and cover they die off in large numbers and the cycle repeats.

Information from Long Point suggests that the fewer years it takes for hare populations to rise from medium to high densities the fewer predators will be present when a hare crash occurs. The longer (in years) hare populations remain high the more predators will be present when the hare crash occurs and the greater the impact upon local secondary prey species.

Scientists in northern Europe have been looking at chemical defence mechanisms used by plants against browsing hares for several years (Jokinen 1982). These studies indicate that plant species respond to browsing by producing toxins which make them nearly unpalatable to hares. This plant response may help to explain why, even lacking predators, hare numbers do not recover quickly and why, in some areas, hare populations undergo radical declines in spite of what appears to be ample available food. The palatability of food in the areas providing cover may not be nutritious enough for the survival of young growing hares. This phenomena is currently receiving considerable study in North America (Radvany 1987).

The significance of hare densities within white-tailed deer (Odocoileus virginianus) and moose (Alces alces) winter ranges requires more study. Competition for food will be greatest when high hare densities occur in years of high winter severity, since the greater the snow depth the higher hares will be able to reach in quest of food. Wolff (1982) showed that in some Alaska habitats peak snowshoe hare densities have a significant impact on moose browse. After a peak hare density, however, there are several years during which the vegetation recovers.

A study of lynx carcasses retrieved from provincial trappers found that several year classes were missing in the carcasses sampled (Koonz 1976). These missing years corresponded to years of low snowshoe hare densities. Hares were found to comprise over 60% of the lynx stomach contents in all study years.

The energistics of hares and small mammals requires more study to determine if the food requirements of hares (300 g per day) or red-backed voles (10 g per day) approach the amounts available in their Long Point activity zones when populations are at peak. As prey numbers increase, their food and cover decrease, resulting in increased vulnerability and the need to forage farther and to expend more energy to obtain less nutritious food. Also, as population densities increase so do interactions, resulting in higher parasite infestations and stress due to crowding.

Small mammal density monitoring has been used to estimate terrestrial furbearer population trends in Russia since at least 1943 (Chirtkova 1953). Snowshoe hare and small mammal monitoring can likely be

used in the management of several Canadian species, namely lynx, fisher and red fox. The value of such management techniques in Manitoba has yet to be determined.

To gain a perspective of plant and animal interactions in a given habitat, it is necessary to look at both plant and animal species components. Through observing and monitoring natural floral and faunal phenomena over long time periods wildlife population trends can be understood well enough to assist in species management.

CONCLUSIONS

Snowshoe hare and small mammal populations on Long Point, 1971-87, illustrate fluctuations which impact upon and can be used to predict furbearer, raptor and upland gamebird population trends as well as forest regeneration. These trends vary according to habitat and can assist in the development of long term management procedures for furbearers and upland gamebirds. Monitoring of key habitats in this fashion may also be of value to raptor and big game management (deer, moose), although more information is required.

Continued fire suppression of Long Point vegetation communities will result in the uplands becoming more dominated by spruce forest. This will result in species diversity reductions in the ground cover, shrub and tree zones. With this floral situation, hare and small mammal populations will have lower mean densities and will undergo less dramatic density fluctuations, as will the populations of predators dependent upon them.

LITERATURE CITED

Bryant, J.P. 1981. The regulation of snowshoe hare feeding behavior during winter by plant antiherbivore chemistry. Pages 720-731 in K. Myers and C.D. MacInnes, eds. Proc. World Lagomorph Conf., Univ. of Guelph, Guelph, Ont.

Cayford, J.H., and D.J. McRae. 1983. The role of fire in northern circumpolar ecosystems. Great Lakes Forest Research Centre, Can. For. Serv., Ont., Can. pp. 183.

Chirkova, A.F. 1953. Dynamics of fox numbers in Voronezh province and forecasting of fox harvests. Voprosy Biologii Pushnykh Zverey, Vol. XIII, Moscow, 1953, 20p.

Getz, L. 1972. Social structure and aggressive behavior in a population of Microtus pennsylvanicus. Can. Jour. of Mammalogy. Vol. 53, No. 2, pp. 3110-3117.

Giles, R.H. 1969. Wildlife Management Techniques. The Wildlife Society, Washington, D.C., pp.410-412.

Iverson, S.L., and B.N. Turner. 1972. Winter coexistence of Clethrionomys gapperi and Microtus pennsylvanicus in a grassland habitat. Am. Midland Naturalist. 88:440-445.

Jokinen, M. 1982. Chemical defence mechanism of woody plants against hare browsing-a review of facts and ideas. University of Helsinki, Finland Lammi Notes 7, 22-23.

Keith, L.B. 1963. Wildlife's ten-year cycle. The University of Wisconsin Press. Madison. pp.201.

Keith, J.R. Cary, O.J. Rongstad and M.C. Brittingham. 1984. Demography and ecology of a declining snowshoe hare population. Wildlife monographs No. 90. 43pp.

Koonz, W.H. 1976. A biological investigation of lynx in Manitoba. Dept. of Nat. Res. Ms. Rept. 76-2:35p.

Lack, D. 1954. The natural regulation of animal numbers. Oxford at the Clarendon Press. pp. 343.

Loewen, V. and G. Mowat. 1987. A proposal to study a boreal vertebrate community. Fourth Northern Furbearer Conference abstracts Juneau, Alaska. p. 20.

Norberg, R.A. 1987. Evolution, structure, and ecology of northern forest owls. In: Biology and conservation of northern forest owls, symposium proceedings, Winnipeg. U.S. Dept. of Ag. Fort Collins Colorado Tech. Rept. R.M. - 14pp. 32-36.

Parmeter, J.R. 1978. Forest stand dynamics and ecological factors in relation to dwarf mistletoe spread, impact and control. Proceedings of the symposium on dwarf mistletoe control through forest management. Apr. 11-13, 1978, Berkeley, California. pp. 16-30.

Phillips, E.A. 1959. Methods of vegetation study. Henry Holt and Company Ltd. pp. 19-22.

Radvany, A. 1987. Snowshoe hares and forest plantations: a literature review and problem analysis. Canadian Forestry Service Information report NOR-X-290 Edmonton, Alberta. 17pp.

Smith, R.L. 1966. Ecology and field biology. Harper and Row, New York and London. pp. 617-618.

Weir, T. (ed.). 1960. Economic atlas of Manitoba. Dept. of Industry and Comm., Province of Manitoba. 81 pp.

Wicker, E.F. Refinement and quantification of data for regulating Dwarf Mistletoe populations: An ecosystems approach. Proceedings of the symposium on dwarf mistletoe control through forest management. Apr. 11-13, 1978, Berkeley, California. pp. 137-142.

Wolff, J.O. 1982. Moose-snowshoe hare competition during peak hare densities. Proc. N. Am. Moose Conference Workshop 18 pp 238-254.

Zimmerman, G.T. and R.D. Laven. 1984. Ecological interrelationships of dwarf mistletoe and fire in lodgepole pine forests. Biology of dwarf mistletoes: Proceedings of the symposium. Aug. 8, 1984. Fort Collins, Colorado. pp. 123-131.

Appendix 1. Names of plants found on Long Point.

Common Names	Scientific Names
Mosses	
Flat feather moss	Musci
High feather moss	Musci
Sphagnum	*Sphagnum* spp.
Cup lichen	*Cladonia* spp.
Tree lichen	*Usnea* spp.
Sedges and Grasses	
Sedge	*Carex* spp.
Grass	Gramineae
Forbs	
Horsetail sp.	*Equisetum sylvaticum*
Bunchberry	*Cornus canadensis*
Twinflower	*Linnaea borealis*
Strawberry	*Fragaria virginiana*
Lily sp.	*Maianthemum canadense*
Violet sp.	*Viola* spp.
Bishop's-cap	*Mitella nuda*
Cow-wheat	*Melampyrum lineare*
Indian-pipe	*Monotropa uniflora*
Vetch sp.	*Lathyrus palustris*
Aster sp.	*Aster* spp.
Bedstraw	*Galium trifidum*
Palmated coltsfoot	*Petasites palmatus*
Harebell	*Campanula rotundifolia*
Dwarf mistletoe	*Arceuthobium pusillum*
Starflower	*Trientalis borealis*
Sundew	*Drosera rotundifolia*

Common Names	Scientific Names
Shrubs	
Bearberry	Arctostaphylos uva-ursi
Blueberry	Vaccinium myrtilloides
Creeping raspberry	Rubus chamaemorus
Bog cranberry	Vaccinium vitis-idaea
Snowberry	Symphoricarpos albus
Bog rosemary	Andromeda polifolia
Crowberry	Empetrum nigrum
Bog laurel	Kalmiapolifolia
Soapberry	Shepherdia canadensis
Rose	Rosa acicularis
Labrador tea	Ledum groenlandicum
Leatherleaf	Chamaedaphne colyculata
Skunkberry	Ribes glandulosum
Buffalo-berry	Shepherdia argentea
Juniper	Juniperus communis
Highbush-cranberry	Viburnum trilobum
Ground cedar	Lycopodium complanatum
Red osier dogwood	Cornus stolonifera
Potentilla	Potentilla palustris
Sumac	Rhus glabra
Saskatoon	Amelanchier alnifolia
Chokecherry	Prunus virginiana
Honeysuckle	Lonicera glaucescens
Alder	Alnus rugosa
Willow	Salix spp.
Trees	
Jack pine	Pinus banksiana
Black spruce	Picea mariana
White birch	Betula papyrifera
Cedar	Thuja occidentalis
Tamarack	Larix laricina